Default Operational Representations of Military Organizations for Joint and Coalition Operations

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Abstract

In a 1998 C2RT Symposium paper [Chamberlain 1998], the thesis was presented that the concept of organization (or task organization) is the central theme by which all battle command representations revolve. In essence, the organizational structure forms a skeleton to which all other battlefield entities can be related, making the organization data structures the rallying point for the integration of other databases, such as logistics, personnel, and communications. However, one of the hypotheses presented states that fluid *Orders Of Battle* (OOB) can most always be built by re-linking existing organizations from a stable default organizational structure. But for this to be effective, the default structure must include more nodes than are present in current default structures. This paper introduces *Default Operational Organizations* (DOO) that are representations of military organizations that meet the requirements necessary to build arbitrary OOBs across joint Services. By looking closely at how each service organizes for combat, basic tenets were developed in an attempt to reduce many practices to a few fundamental concepts. The result is a set of guidelines based upon the "best practices" of all the services.

1. The Organization Server Architecture

Currently, there are numerous approaches for identifying organizations and this is hindering the ultimate goal: the ability to "plug-and-play" task organizations across international and Service boundaries while building Military Capability Packages (MCP). The purpose of an *organization server* is to provide organizational information, in a homogeneous structure, about military forces down to the individual billet level.[1] This also requires that a universal way to identify organizations be defined. A proposed solution is to use a simple numbering scheme—in this case, a 32-bit integer called an *organization identifier* (ORG-ID)—that is capable of covering approximately 4.3 billion organizations if none is wasted.[2] This approach can also be applied across Services, non-government organizations, and countries. To prevent waste, ORG-IDs are *not* assigned by blocks, but instead on a first-come, first-served basis from an *Org-ID server*. Thus, implementation is via a two-tier hierarchy of servers: (1) a set of *Org-ID servers* that pass out unique Org-IDs, and (2) *organization servers* (org servers) that maintain the actual

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[1] Dictionary of Military Terms - http://www.dtic.mil/doctrine/jel/doddict/data/b/00866.html
    Billet: A personnel position or assignment which may be filled by one person
[2] 4.3 billion numbers are enough to uniquely identify every node in approximately 213,000 U.S. Army Divisions.

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assignment of Org-IDs to organizations while maintaining the organizational data; this is illustrated in Figure 1.
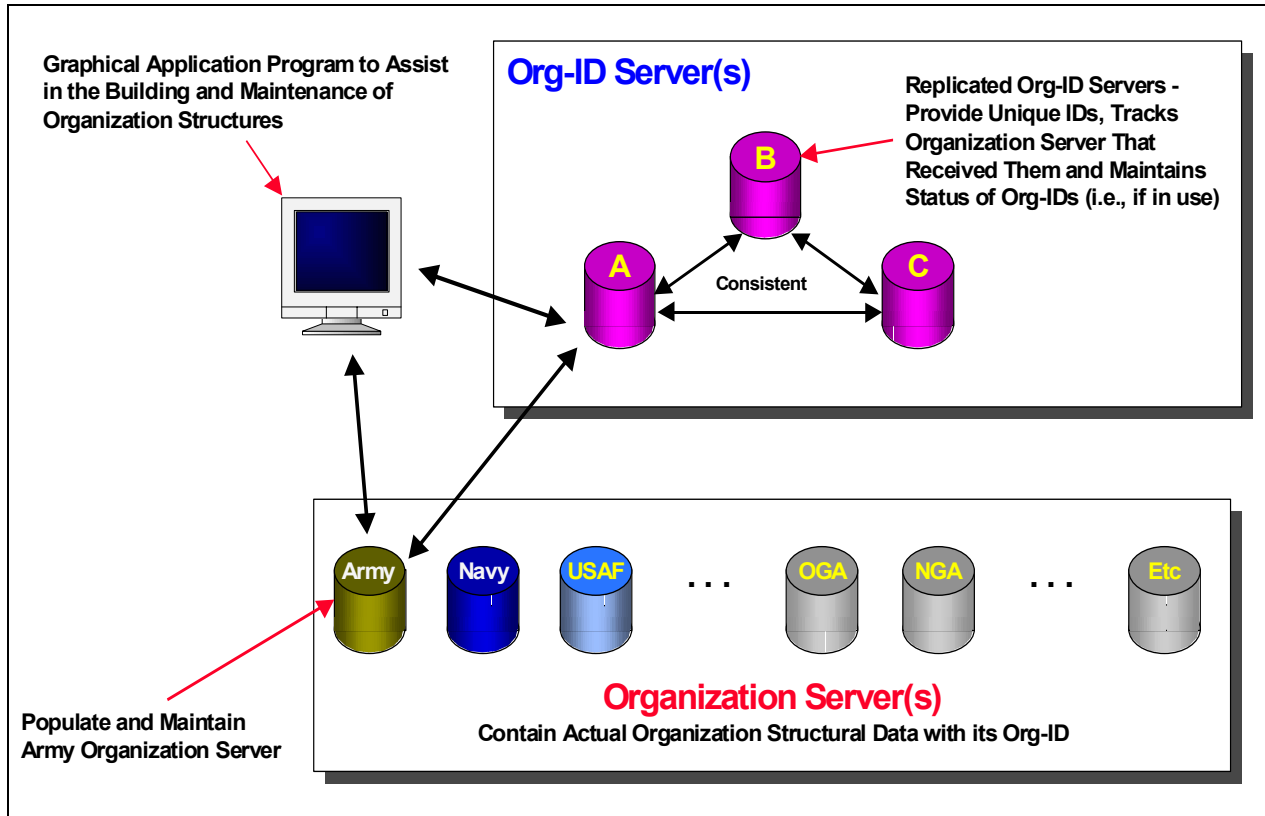

Figure 1: Organization Server Architecture

The separation of Org-ID servers from org servers is significant because it allows selective sharing of order of battle (OOB) information while participating in the open, Org-ID assignment system. It is hoped that this will encourage participation by those who would not otherwise do so for security or sovereignty reasons. The jurisdiction of org servers is completely flexible. For example, within the United States, there could be org servers for each Department of Defense (DOD) service, the Office of the Secretary of Defense (OSD), other Government organizations (e.g., State Department), non-government organizations, and private volunteer organizations. Each org server controls the dissemination of its information; however, it is expected that the DOD members would normally share information with each other (within the usual security limitations).

When an authorized user wants to create a new organization, an Org-ID (or set of Org-IDs) must be obtained. To do this, a request is sent to one of several Org-ID servers. The Org-ID servers authenticate the request and provide guaranteed unique integers to the requester—that is, they ensure that the integers they provide have not been given to any other authorized user. The Org-ID server associates each Org-ID with the org server to which it was delivered, marks the Org-ID as unavailable, and, initially, sets the Org-ID's status as dormant. At a later time, probably within some previously agreed upon limit, when the org server assigns its Org-IDs to real organizations, it must notify the Org-ID server that the Org-IDs are now in service. An org

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server may inactivate an Org-ID at any time, reuse it at it pleases, or even return it to the Org-ID server for reuse. The Org-ID server has little control over an Org-ID once it is delivered to an org server.

2.   A Simple Data Abstraction for Organizational Structure

Ultimately, organizations manifest themselves as organization charts. To formalize the process of building these charts, they are considered in terms of graph theory. A graph is composed of nodes and links (i.e., vertices and edges). A tree is a special graph that is fully connected (i.e., every node is linked to at least one other node) and there are no cycles (i.e., only one path exists between any two nodes). Figure 2 summarizes a few graph theory terms.
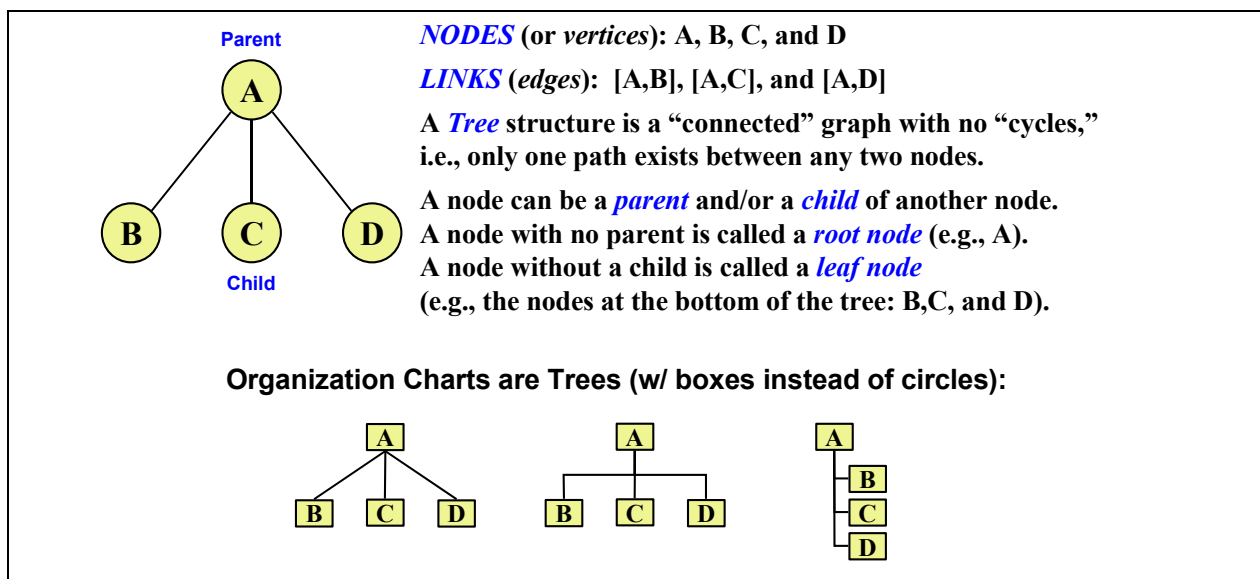
Figure 2: Graph Definitions and Terms

By definition, nodes (e.g., A, B, C, and D in Figure 2) represent **organizations** and links ([A,B], [A,C], and [A,D] in Figure 2) represent **chains of commands**. Each organization (or node) receives an Org-ID, thus allowing chains of commands to be explicitly defined via parent-child relationships between organizations. For example, a link between A and B may be formally defined via the relationship *assigned*[A,B], where "assigned" is the relationship type, A is the parent node, and B is the child node. One of the goals of this project is to produce unambiguous organization charts, which means defining unambiguous chains of command. In other words, there may be more than one chain of command at one time (e.g., one for administration and one for operations), but a given chain of command must be explicit, unambiguous, and have tree properties. Further, one must decide what constitutes a bona fide organization and what the links, or relationships, between them formally represent (e.g., what does the relationship "assigned" mean). This doesn't mean that every system has to display organization charts the same way, but only that the organizational structure should be represented inside the computer using a common set of semantics. If this is done, one can begin to build "plug-and-play" task organization applications that extend across the services, and even coalitions.

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If one asks 10 different people to "draw an organization chart" of their organization, one will often receive 10 different structures. This characteristic is indicative of the informal, human-oriented nature of our battle command processing. Unfortunately, computers aren't clever enough to figure out what all these relationships infer. Consequently, one needs to formally describe the "age-old" chain-of-command relationships terms that are routinely used and have numerous inferred meanings and ramifications. This paper describes several basic tenets for defining this structure in a format conducive to machine manipulation.

3.   Default Operational Organizations

One reason for setting up the org server system is to simplify, enhance, and formalize the task organization process within/between U.S. services and between coalition partners. One hypothesis presented in Chamberlain[1998] is that fluid OOBs can most always be built by re-linking existing organizations from a stable default organizational structure. But for this to be true, the default structure must include more nodes than are present in current default structures. Just entering current manning documents into the org servers (org servers) will not accomplish the desired capability because many important low-echelon organizations are inferred or are missing.[3] Therefore, these organizations must be explicitly added to allow the org server system to meet its potential.

The term *Default Operational Organization*, abbreviated DOO, is introduced as the name for the enhanced organizational structure that is maintained in the org servers. The DOO is the conceptual "stable," generic organization that represents the "relaxed" state of the force before it is task organized. It begins at some arbitrary high echelon (e.g., DOD) and continues all the way down to the individual warriors. A DOO is constructed by two tasks. First, the current administrative organization represented by standard manning documents is translated into "nodes" and "links" (i.e., organizations and a default chain of command). This may require some basic modifications to remove circular, duplicative, and ambiguous links that can cause logic problems and prevent the graph from being a tree. Second, three other types of organizations are added to fill in the many gaps left after translating the manning documents. These types are: *billets* (organizations that have a one-to-one correspondence with a person), *crews* (or organizations that are created for the purpose of operating a piece of equipment), and *doctrinal organizations* (based upon operational fighting doctrine or heuristics). The next part of the paper discusses these "interesting cases" and anomalies discovered during their definition.

3.1   Billets and Commanders

Approximately 80% of the organizations in a force reside in the "leaf nodes" of the organizational hierarchy that correspond to individual people—officially called *billets*. Current operational military organization databases extend down to the "Company Level" in the Army and Marine Corps. A Unit Identification Code (UIC) that is used for strategic planning purposes is assigned down to this echelon. However, UICs were established for logistical reasons, not for command and control. The company level was chosen as the lowest echelon because it is where

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[3] Manning documents include Army *Tables of Organization & Equipment* (TO&E), Air Force *Unit Manning Documents* (UMD), Navy *Ship Manning Documents* (SMD), and Marine Corps *Tables of Organization/ Equipment* (TO/TE).

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supplies are delivered. It is important to realize that this is an arbitrary stopping point in the process of defining organizations. If one continues expanding an organization chart, eventually one will produce organizations that have a one-to-one correspondence with a person. This echelon is called a "billet" in the official DOD dictionary and is illustrated in Figure 3.

In the general case, billets correspond to "warrior" positions. These are the personnel positions that are occupied by soldiers, sailors, airman, and marines doing the many tasks required of a military force. People are ultimately assigned to billets, but this does not change the fact that billets are just another organization. However, the association between a person and a billet is technically different than the association between two organizations. There are many different types of associations, henceforth referred to as relationships. To differentiate between the two categories, they will be called *organization-to-organization relationships* (OTOR) and *personnel-to-organization* relationships (PTOR). In Figure 3, the links between organizations (such as A and B, or B and F) are OTORs, while the arrows between people and organizations (such as U to D, or Z to I) are PTORs. Many OTORs already exist with names such as *assigned*, *attached*, *operational control*, and *direct support*. PTORs are less formally defined. Both the number and description of OTORs and PTORs will have to be enhanced to formally cover the many cases that occur in real life. One example may be a PTOR for *acting* roles to indicate that a person both occupies one billet but is also temporarily serving in the capacity of another. This is common when a commander goes on leave and another officer is "put in charge" during the absence. Another interesting situation is that it is not unusually at the upper echelons (e.g., for flag officers) to be assigned to several billets at one time. This is referred to as "wearing several hats." For example, the person filling the billet of Commander, U.S. Forces Korea (USFK), also fills the billet of Commander, United Nations Command (UNC), and Commander, Republic of Korea-U.S. Combined Forces Command (CFC).

A special case is "command billets." It is important to be able to ascertain who is the commander of an organization. However, command billets are often nested several layers down
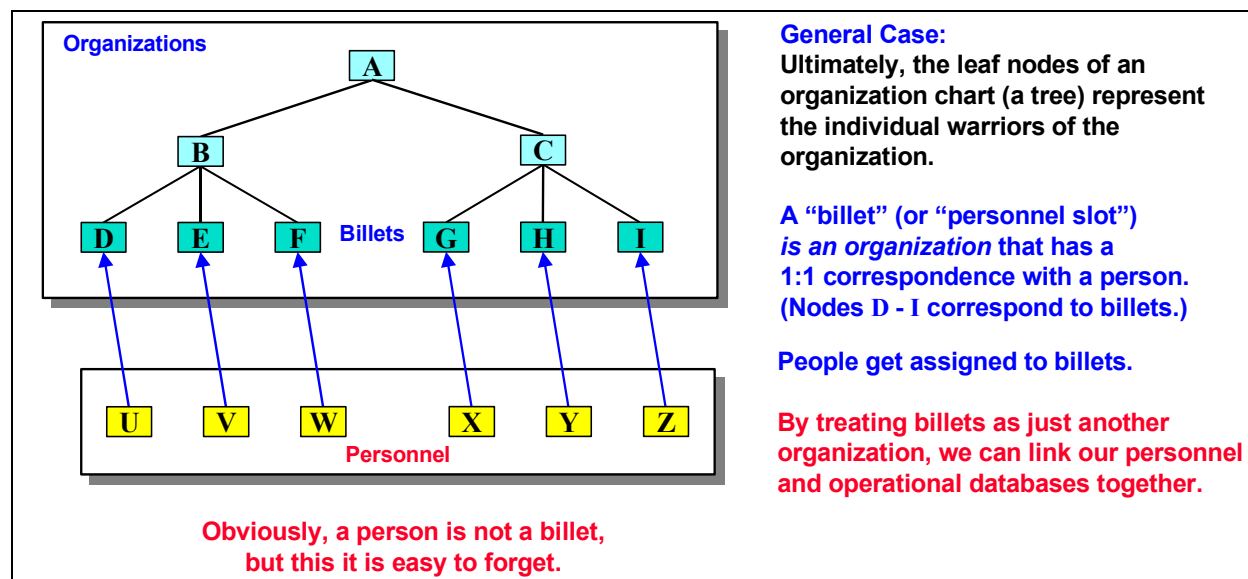

Figure 3: Billets Ultimately Form the Leaves of the Trees

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from the organization that is actually commanded. For example, the command billet for an Army Division is a sub-element of a "Command Section," that is a sub-element of a "Headquarters and Headquarters Company" (HHC), that is a sub-element of the organization called a "Division." This hierarchy is illustrated in Figure 4. This relationship is relatively easy to understand with some military experience coupled with an organization chart that includes echelon symbols and organization names as in Figure 4.

However, a more formal description is required for computers that must deal with an abstract chart such as that shown in Figure 5. To fix this problem, a new OTOR called *is-commander-of*, which links a command billet with the organization for which it has command, is introduced. This is illustrated in Figure 5 between nodes F and A and between nodes H and B (note: Figure 5 is the abstract case of the example shown in Figure 4). Because a PTOR exists to assign person X to organization F (a command billet), it is easy to determine that person X is in command of organization A (e.g., MG Jones is in command of the 32d Division in Figure 4). In formal terms, *is-assigned-to*(X,F) AND *is-commander-of*(F,A) implies *is-commanded-by*(X,A), which is a derived PTOR. Thus, no matter where a command billet is placed, one can easily ascertain who is in charge of what.
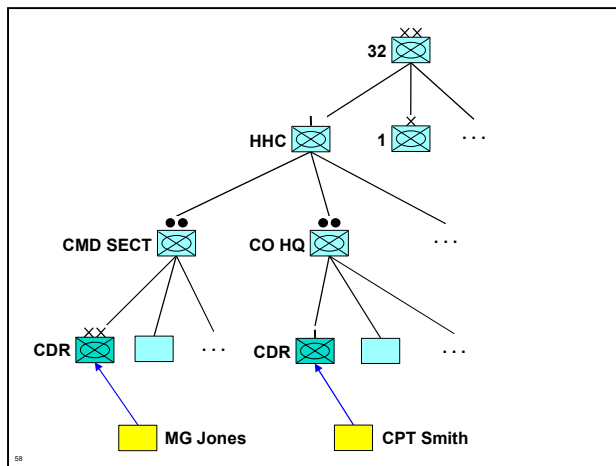

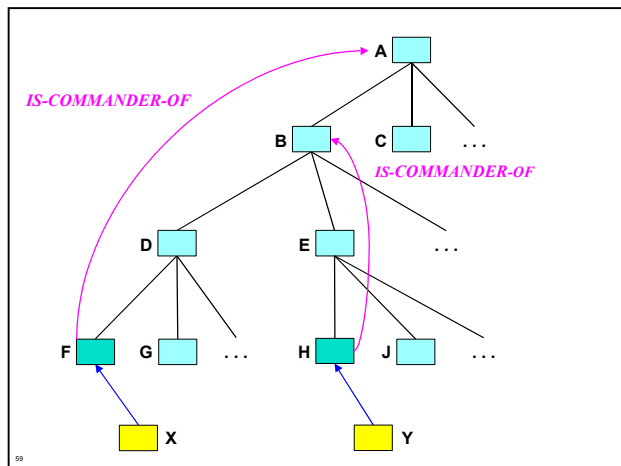
Figure 4: Nested Command Billets   Figure 5: Abstract View of Nested Command Billets

Figure 4 and Figure 5 still have a significant problem. Because Army TO&Es are logistic based, the tree structure focuses on logistic responsibility rather than the chain of command. Notice that there are two command billets under one node (i.e., nodes F and H under B, which, in-turn, is under A). This produces an ambiguity when rules of transitive closure for trees are followed.[4] Typically, if A is in command of B, and B is in command of C, then A is ultimately in command of C. But there is a contradiction in Figure 5:

B *is-a-child-of* A AND H *is-a-descendent-of* B;
Since F *is-commander-of* A AND X *is-assigned-to* F AND Y *is-assigned-to* H,
THEN Person Y must be ultimately commanded by Person X.

However, if one looks at the tree rooted at node B, there is a different conclusion:

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[4] Transitive closure states that IF A=B AND B=C, THEN A=C. Likewise, the '=' relationship may be replaced by some other relationships: IF A *is-an-ancestor-of* B AND B *is-an-ancestor-of* C, THEN A *is-an-ancestor-of* C.

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Like H, F *is-a-descendent-of* B;

Since H *is-commander-of* B AND Y *is-assigned-to* H AND X *is-assigned-to* F,

THEN Person X must ultimately be commanded by Person Y.

Both of these statements cannot be true. A conclusion should not depend on which node one begins the process. This problem is caused by a cycle in the graph that is a result of the Division Command Section being placed, for logistics reasons, under an HHC that also has its own commander. This practice occurs at all level above the company echelon (where HHCs exist) because the subordinate organization (the HHC) has responsibility for the commander's equipment. Thus, the practice of building "official organizations charts" based on logistic, rather than chain-of-command, considerations can cause command ambiguities if not treated correctly.

To fix this problem, "command groups" must be pulled out from under subordinate commanders to prevent circular command chains. This revives the "tree property" of the organization chart and provides a clean chain of command structure as is illustrated in Figure 6. A new OTOR called "has logistics responsibility for" can be added to formalize the fact that the HHC still has responsibility for the equipment of the command group.
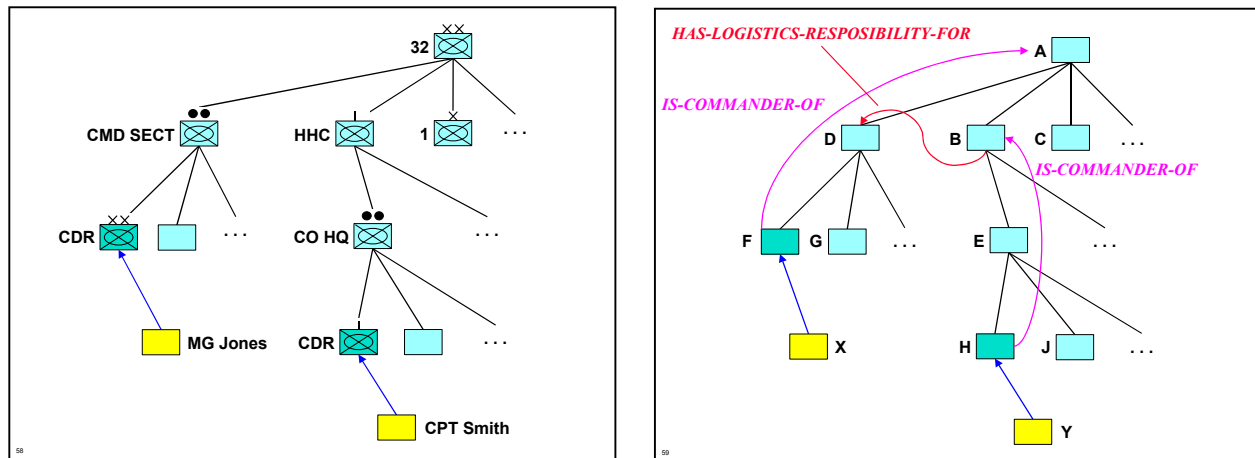

Figure 6: Non nested Chain of Command

3.2 Crews

A common practice is to create an organization, commonly called a *crew*, for the purpose of operating a specific piece of equipment. Crew sizes vary widely from a single person, such as a fighter pilot, to thousands of people, such as a ship's crew, organized into many sub-organizations. The purpose of this study is to attempt to identify common, general traits, and practices that can be applied to the organization data abstraction process regardless of crew size or the equipment operated.

Of particular interest is the manner in which one associates a crew with its equipment. For this discussion, the term "asset" is used interchangeably with equipment because it more generally characterizes the problem. By definition, the process of associating an asset to an organization is coined *alignment*. Therefore, to describe alignments, a new category of relationship called *equipment-to-organization* relationships (ETOR) is introduced to accompany OTOR and PTOR.

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In this section, the term "assignment" is used for OTORs to complement the term alignment for ETORs. Thus, the associations between organizations, people, and equipment can now be unambiguously defined.

There is a famous saying that "the Air Force and Navy man equipment, while the Army and Marines equip the man." Although this is an obvious exaggeration, it represents two philosophical differences that show up between types of crews. One interpretation is that the difference between *habitual* and *non-habitual* relationships is what is actually being reflected. This is true for OTORs, PTORs, and ETORs. In other words, a relationship between organizations, a person and a billet, or an asset and an organization can have a default mode of either habitual or non-habitual and this has a dramatic effect on the perception of the organizational structure[5]. For example, some may prefer the word "system," as opposed to crew because the asset is the focus of the operational task at hand. This is perfectly acceptable as long as the semantics are consistent. There is nothing special about crews other than the fact that they correspond to a major asset, such as a vehicle, aircraft, or ship.

PTORs are normally habitual. Typically, a person is assigned to a billet for the duration of a tour of duty. However, the billets that make up a crew may be habitual or non-habitual (represented via OTORs). The same is true for ETORs (alignments). This is illustrated in Figure 7. For
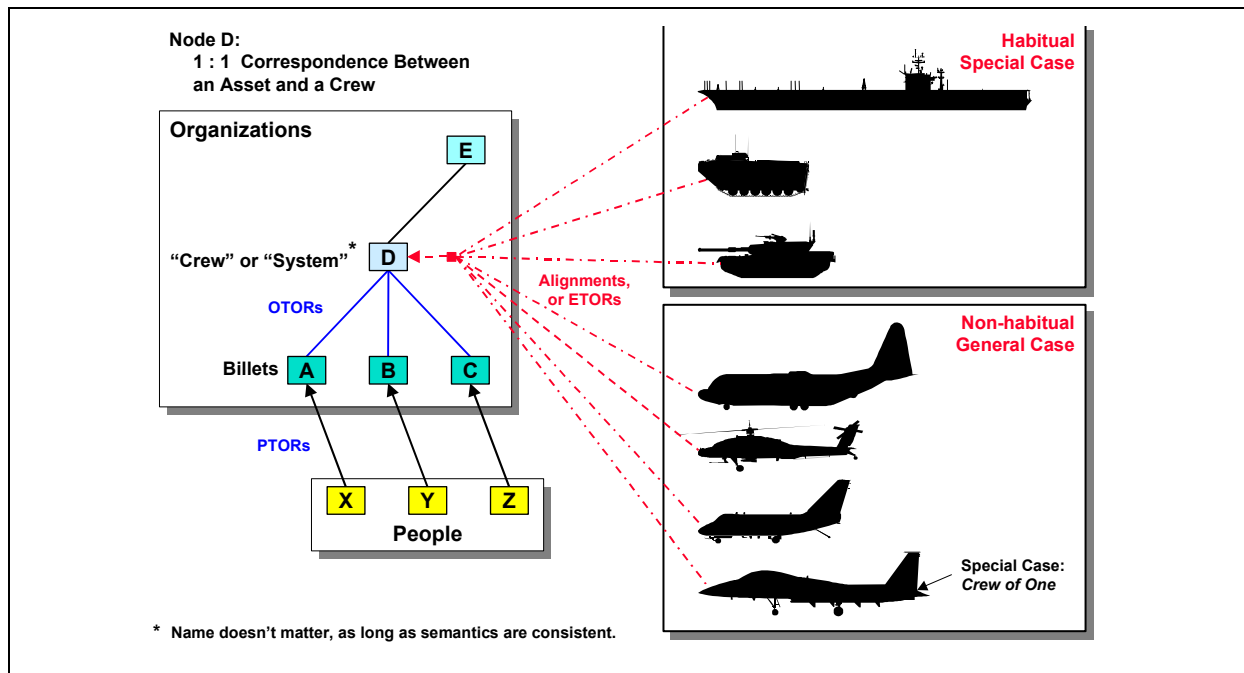

Figure 7: Example of Habitual and Non-Habitual Relationships

ground and naval forces, crews assignments and alignments are typically habitual. The same people usually work together and operate the same equipment each time. Aviation units, on the other hand, attempt to keep crews together, but this is by operational practice rather than by organizational structure. Aviation alignments (ETORs) are non-habitual. Aircraft are provided

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[5] To quote a corollary of Murphy's Law: "Where one stands on an issue depends on where one sits."

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based on maintenance and other scheduling criteria. No one has a "personal" aircraft.[6] There are many interesting ramifications caused by habitual versus non-habitual relationships. However, because the habitual case is more constraining, the non-habitual case should be considered the general case, and not vice versa.

3.2.1   Assignments, OTORs, and Organization Trees

Habitual crew assignments are the most common default for ground and naval forces. For example, an M1A1 tank crew is composed of four billets: a tank commander, a gunner, a loader, and a driver. The four people assigned to these billets think of themselves as a permanent team. Unless there is a significant anomaly, they train and fight together. When they "fall out for formation" in the morning, they will be standing next to each other. They may even be roommates. Habitual crew assignments manifest themselves in organization trees by the billets being shown under the crew as the default case as is illustrated in Figure 8.
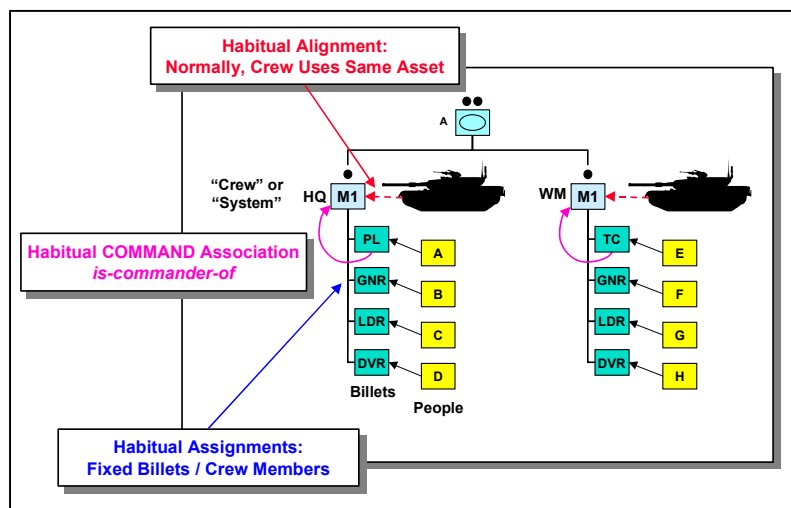

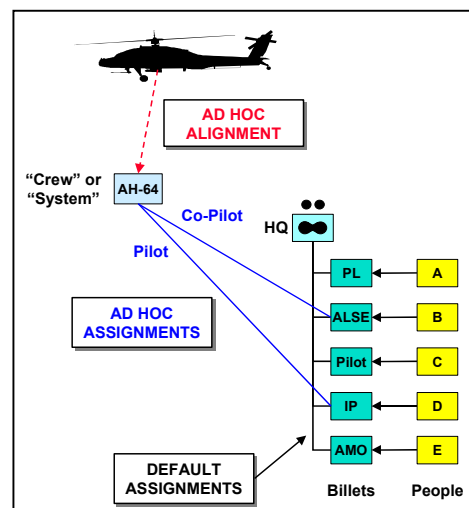Figure 8: Habitual Assignments and Alignments

Figure 9: Non-Habitual Relationships

Although habitual crew assignments are desirable, they are not always practicable. Aviation crews (i.e., those greater than one) may be composed "ad hoc," based upon many variables (e.g., a crewmember's need for training hours).[7] Although an attempt is made to keep crews together, this is not reflected on the organization charts. Instead, crews are composed before each mission, and although the same crew may frequently fly together, this is not reflected in the default organization tree as is illustrated in Figure 9. Under this process, the crewmember billets can be considered temporarily "attached" to a crew (organization) for the duration of the mission, after which the billets return to their default (assigned) organizations. Also notice that OTORs (i.e., the links) can be named (e.g., "pilot" and "copilot"). This is especially useful for recurring temporary links. An excellent example is found in Marine Expeditionary Units (MEU), where

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[6] People in organizations that are habitually aligned are surprised to discover that the fighter pilot of an aircraft is rarely the person whose name is on the aircraft!

[7] An extreme example is airline crews, where crew composition is determined according to seniority and many other factors. Therefore, a pilot, copilot, and the several flight attendants may meet for the first time just minutes before a flight.

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the attached OTORs for the air, ground, and support elements can be named permanently (e.g., the ACE, GCE, and MSSG links). Neither the habitual nor non-habitual approach to assignments is right or wrong; they are just different. The important point to remember is that either case must be equally viable within a data model of organization structure and the user must be free to mix and match in any way deemed necessary to properly represent its structural state.

3.2.2   Alignments, ETORs, and Organization Trees

The most notable feature of a crew is the one-to-one correspondence with a major asset. This means that for every "crew-served" piece of equipment, there is a corresponding organization. For example, there is a ship hull (a piece of materiel) called "CVN-73." However, there is also a corresponding organization called "Crew of the USS George Washington" (or some other name of choice) that is composed of Departments, Divisions, Work Centers, billets, and other subordinate organizations. If the piece of equipment named CVN-73 suddenly sank, there would still be a crew of 5,000+ people "floating in the water" complete with a hierarchical chain of command. Thus, one should not confuse a piece of materiel with the corresponding organization. This was illustrated in Figure 7, where Node D is the corresponding crew organization for the various examples of materiel. As mentioned previously, it is perfectly acceptable to think of the corresponding organization as a "system" rather than a "crew." The former presents an asset perspective while the latter provides a personnel perspective. Either is equally acceptable provided that the rules for manipulating the organizations remain consistent.

Alignments (the association between equipment and an organization described via ETORs) can be either habitual or non-habitual. Crews with habitual alignments always use the same asset (this is illustrated in Figure 8). The crews think of the asset as "theirs" (e.g., "my ship" or "my tank"), and they are normally responsible for some level of maintenance. During the force development process, crew design is normally based on a one-to-one ratio of crews to assets. Consequently, the force structure that is deployed "to fight" (i.e., is task organized) looks very similar to the default force structure seen in garrison. This is because there is a consistent match between the association of personnel and assets with the hierarchical organization structure. For example, an Army M1 tank company has 14 tanks; therefore, there will be 14 crews built into the force structure of the company. Whether in a deployed state or garrison, pairs of crews are defined as Sections, pairs of Sections are defined a Platoons, and a set of Platoons (actually three) constitute the Company.[8] Although the Tank Company Commander technically "owns" (i.e., has ultimate pecuniary responsibility for) all the vehicles, they are parceled out on a semipermanent basis to the leaders of each crew.

Non-habitual alignment, the normal default for aviation organizations, is the less constrained, general case.[9] The primary reason for non-habitual alignment is that the assets (aircraft) require intensive maintenance on a regular basis; therefore, it does not make sense to associate a particular crew with a particular piece of equipment. Due to the complexity of the maintenance, non-habitual crews rarely do basic maintenance and a full (often larger) maintenance organization accompanies the sets of crews. During the force development process, the

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[8]   The other pair of tank crews operates as a Section in the Company Headquarters.
[9]   Force developers not familiar with non-habitual alignments often miss this fact.

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organizational design is normally based on a higher crew-to-asset ratio (e.g., 1.5 crew per asset) because the assets are (1) limited in number due to their cost, and (2) are complex to operate and require crew rest between missions.[10]

One consequence of a non-habitual alignment is a large difference between the default and deployed (i.e., task organized) organization structure. Since crews are not habitually aligned with an asset, the primary problem becomes how to represent the assets organizationally when a flight crew is not using them. There are many ways to do this, and two extreme approaches will be discussed. The first approach is to think of the organization as a placeholder for the asset. This is the "system" perspective (referred to previously) that focuses on the asset rather than the crew; in other words, one thinks of the problem as "aligning people to assets" rather than "aligning assets to people"—either approach is equally valid. For example, each Air Force squadron has a number of Prescribe Authorized Aircraft (PAA) that defines the number of aircraft allocated to the squadron. Under this approach, illustrated in Figure 10, there would be
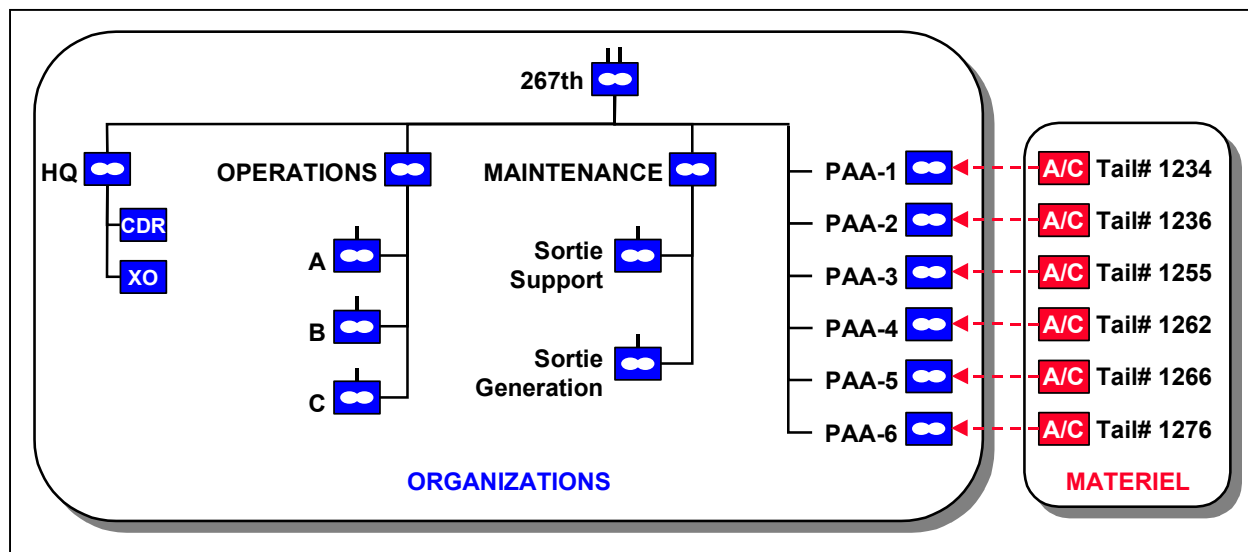

Figure 10: System Oriented Approach To Non-Habitual Alignments

one "system" (or "crew") organization for each PAA. If the PAA were six, then there would be six system organizations called "PAA-1" through "PAA-6" (for example). To each of these positions there would be an aircraft (a piece of materiel) aligned under some ETOR. The default structure might place the "PAA" organizations directly under the squadron root node because the commander is ultimately responsible for all the aircraft. When the time comes to fly a mission, a crew is composed by attaching billets that reside under the operational flights (i.e., A, B, and C) to the PAA nodes.

At the other extreme, one may envision asset alignment as establishing a temporary ETOR to the organization that has current responsibility for the asset. Figure 11 illustrates a hypothetical structure using an Air Force Fighter Squadron. In this example, there are two categories of crews: flight crews and maintenance crews. Flight crew organizations reside under the set of

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[10] An interesting adjunct to this is ballistic missile submarine crews, which are habitually aligned but have a ratio of two crews per asset to allow maximum use of the assets (i.e., a "blue" crew and a "gold" crew per submarine).

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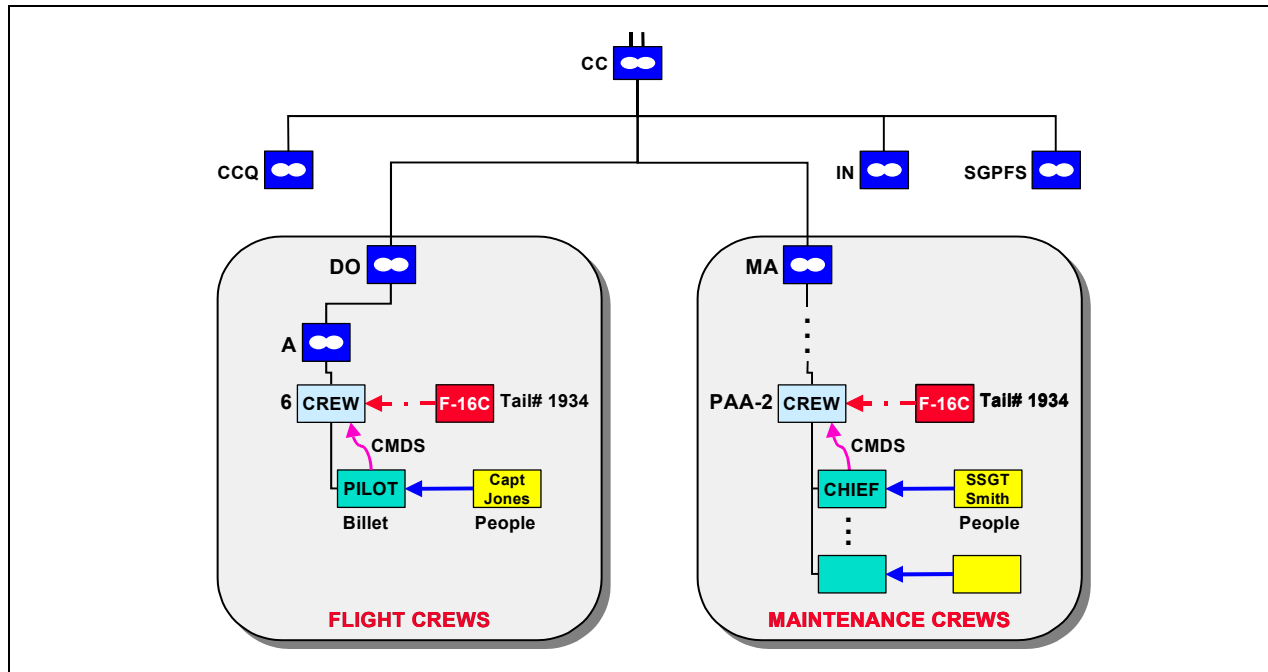Naval War College, Newport, RI; 29 Jun-1 Jul 1999

Figure 11: Crew Oriented Approach to Non-Habitual Alignments

operations flights while maintenance crew organizations reside under the set of maintenance flights. Although, like the other services, the commander actually "owns" all the assets, one can think in terms of passing "sub-hand-receipts" from the commander to the two crews as each takes responsibility for the asset. Initially, the aircraft is "given" to a maintenance organization that takes responsibility for it while it is not involved in flight operations. When the time comes for a mission, responsibility for the aircraft is transferred to the crew executing the mission (led by the aircraft commander).[11] When the mission is completed, responsibility is returned back to the maintenance crew (led by a "Crew Chief"). This cycle continues regardless of where the asset is located. The asset is always aligned to the organization responsible for it.[12]

Notice the difference between the two approaches. In the first approach, called the system approach, the alignment between the aircraft and an organization ("system") is fixed and crewmembers are attached to the system (organization) as required. In the second approach, called the crew approach, asset alignment is moved between organizations based on which one has responsibility for the asset. Either approach is viable, as well as any mixture of the two extremes. However, in the next section (on Doctrinal Organizations), advantages of the second approach are explained.

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[11] Note that crews, like any other organization, may have several levels of subordinate organizations below them (e.g., a ship's crew), and ultimately, those subordinates will be billets. Figure 11 illustrates an extreme case, an Air Force Fighter Squadron, in which the asset requires only a single crewmember (i.e., only one billet per crew).

[12] Although this example has both crews within the same squadron, this is not the case with larger aircraft, such as AWACS, where separate squadrons (e.g., Aircraft Generation Squadron) have responsibility for maintenance.

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3.3   Doctrinal Organization

Many of the organizations used routinely in military operations do not show up in manning documents; these types of organizations have been coined "Doctrinal Organizations."[13] Most doctrinal organizations are in the bottom three levels of the organization hierarchy (the bottom level being the billet). They are usually based upon operational heuristics and span both default and operational (i.e., task organized) organizational structures. For example, the heuristic "always try to fight in pairs" is almost universal, yet, in official organization charts, one rarely finds the organizations that are routinely used as a result of this rule. From this basic heuristic, the concept of "lead" and "wingman" appear in every Service's jargon as do "section," "element," or "team." In the Army, Navy, and Marines, a pair of assets is often termed a "section," and in the Air Force it is called an "element." Yet, one will rarely find these organizations listed in any official manning document (e.g., see footnote 3). Within a manning document, doctrinal organizations may be inferred and a knowledgeable person may be able to extract the structure from information such as billet titles. But in practice, doctrinal organizations are found explicitly only in Field Manuals and other documents that discuss tactics and operational procedures. Figure 12 illustrates this situation for a U.S. Army Mechanized Infantry Platoon (note: the leaves of the trees are billets and the four "M2 Crews" are each aligned with a Bradley Infantry Fighting Vehicle).

The importance of doctrinal organizations cannot be over emphasized because without them, a primary advantage of this process is not realized. As previously stated, one of the basic hypotheses presented in Chamberlain [1998] is that new organizations are not created when
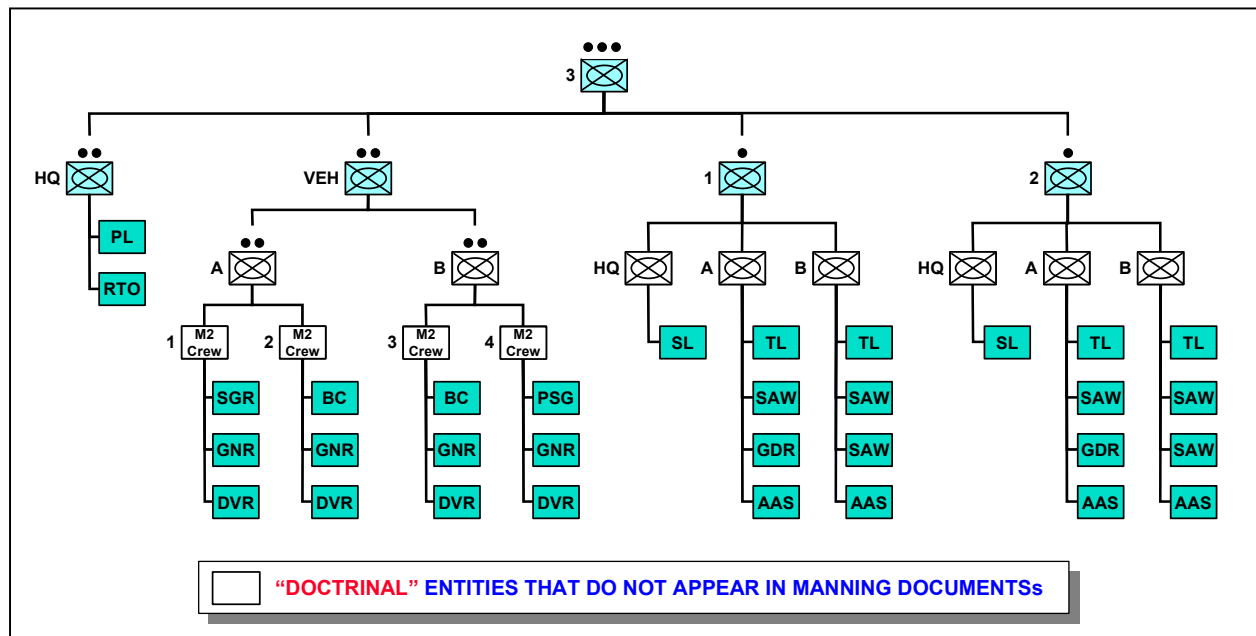

Figure 12: Doctrinal Organizations Missing From Manning Documents[14]

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13   By MAJ Mike Boller, of the U.S. Army TPIO-ABCS, thus replacing other, less descriptive terminology.

14   Information from FM 7-7J, Mechanized Infantry Platoon and Squad (Bradley), Dated 7 May 1993 and TO&E 07247F000, RFL CO INF BN (MECH) (XXI), Dated 23 Apr 1998.

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building most operational chains of command. Instead, task organizing simply requires the re-linking of existing organizations. This is illustrated in Figure 13. The top two boxes in Figure 13 shows two "pure" Army companies: one tank and one mechanized infantry. However, it is often advantageous to mix the assets of the two organizations to provide a more robust and effective fighting team. In this case, the two companies "swap" one of their platoons for one from the other. From a data abstraction perspective, what has occurred is that two new OTORs have been temporarily added to a data table: one for each swapped (i.e., attached) platoon that explicitly represents that from Time X to Time Y each of the swapped platoons has a new, temporary parent organization. Note that their default (assigned) parent relationships never change. Rather, a new temporary relationship has superseded them. In Figure 13, this new relationship is illustrated via a dashed line.
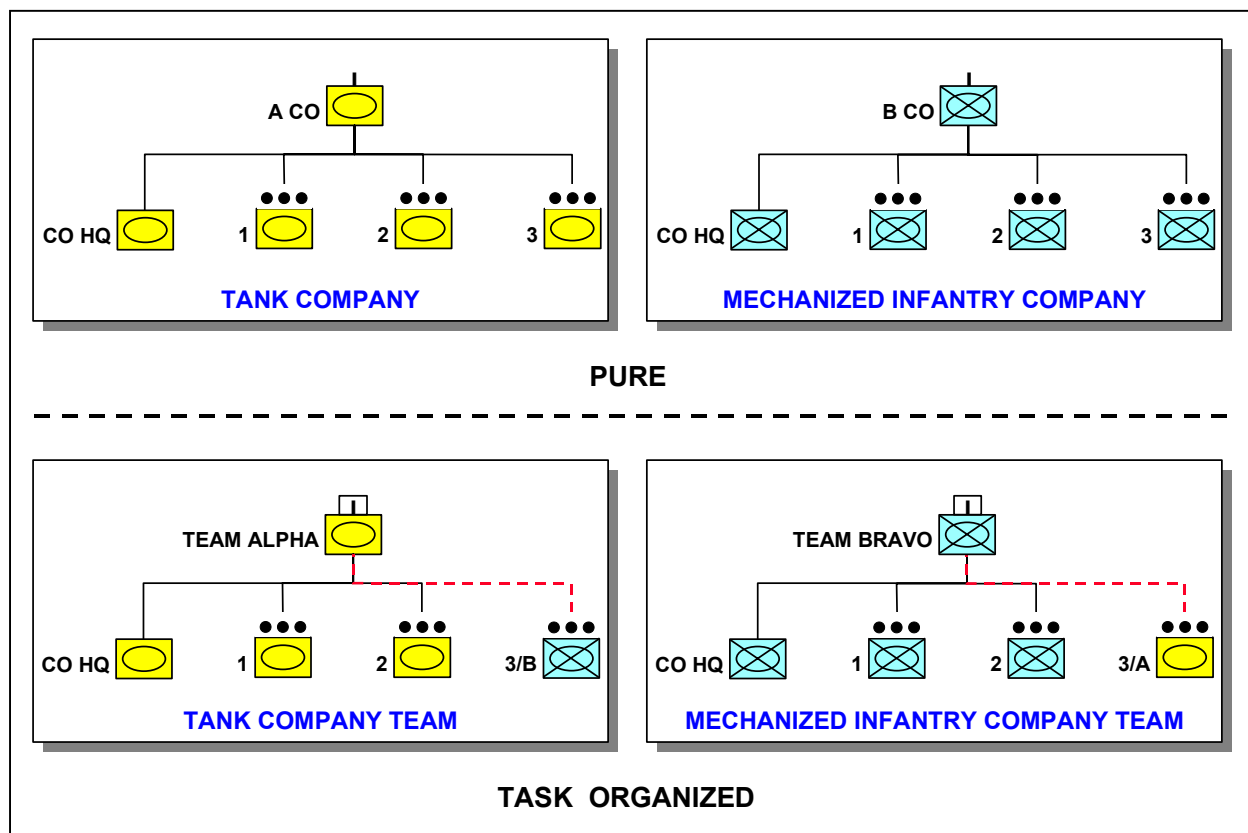

Figure 13: Task Organizing Does Not Require Creating New Organizations

In this example, no new organizations (i.e., nodes in an organization tree) were created. In other words, no new Org-IDs were created. What did occur was the creation of two temporary links (i.e., edges) between some nodes in the graph. When this occurs, doctrine refers to the companies as "teams," and they are often provided a temporary alias (e.g., "Team Alpha" and "Team Bravo"). Further, their military symbol is altered by adding a "hat" to the company's echelon indicator to reflect this temporary arrangement in organizational structure. Eventually, these links will expire and the graph will return to its original (default) condition.

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Since, from a graph theory perspective, no new nodes have been created, it is argued that no new organizations have been created; instead, the chains of command have been augmented. The beauty of this approach is that it means that a stable set of organizations can be created ahead of time to be re-linked at a later time at the discretion of the command. In other words, although the links between nodes (OTORs), people and nodes (PTORs), or equipment and nodes (ETORs) are constantly being augmented, the identification of the node, the ORG-ID, is a stable entity. This has dramatic consequences because the organization database entity becomes the stable rallying point by which all other dynamic attributes are tracked. For example, as a result of the simple task organization illustrated in Figure 13, the networked computing equipment of the organizations involved may require new network addresses and additions/subtractions from associated routing tables. All of this can be automatically reconfigured because the equipment, personnel, and communication channels are all related via the central concept of the organization (identified via Org-IDs). Thus, the formal organization structure provides the enabling core information that is prerequisite for building truly adaptive and self-configuring systems.

However, for this approach to work, the correct organizations must be available to which to temporarily attach, and most of these organizations are doctrinal organizations. If they don't exist, new nodes must be created, and this would cause a huge burden on the command, administrative and communication systems of the organization. Thus, it is imperative that the time and expertise be committed to insert explicit doctrinal organizations into manning documents and the force development process. The aversion is that adding doctrinal organizations to current manning documents is a time-consuming and intellectually taxing activity that must be done by domain experts that have a rigorous understanding of military operations. But the pay-off is large.

3.4   Putting The Pieces Together

When all the pieces are combined, one has (by definition) a Default Operational Organization. In other words:

Default Operational Organization (DOO) =

	Administrative Organization (e.g., TO&E, UMD, TO/TE, SMD)	(a)
+	Doctrinal Organizations	(b)
+	Crews	(c)
+	Billets	(d)
+	Administrative Organization "Fixes" (e.g., Command Structure)	(e)

This is the organizational structure that is maintained in org servers to be shared (to the extent desired) within the Service and between joint and coalition partners. By including these organizational building blocks into one, homogeneous structure, an immensely flexible capability that allows commanders to construct any imaginable task organization with widely shared, predefined entities is provided.

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A simplified example is illustrated in Figure 14 for an Air Force Strike Package. In this scheme, doctrinal organizations called "Elements" are inserted under the flights. Since deployment in pairs (or larger groups) of assets is desirable, one element is introduced for every two assets in the squadron's PAA. Using the crew approach (versus the system approach), each element has two crew organizations subordinate to it. Assets will be aligned with these (crew) organizations. Under the crew echelon resides the crew billets, thus completing the organization tree down to the individual level within the Default Operational Organization. Since this example is an F-16 Fighter Squadron, there is only one billet per crew (note: only one of the six billets is shown in Figure 14, and none of the people assigned to the billets is shown in the DOO). In this special case, there is a temptation to dismiss one of the two entities (crew or billet) as redundant, but this would deviate from the general nature of the problem. If application software expects billets under crews, then deleting crews (for example) could introduce anomalies. Finally, people (e.g., pilots) are assigned to the billets (via PTORs). It is assumed in this example that the aircraft are aligned (via ETORs) with maintenance crews until the flight crews (i.e., pilots) need them.

When a mission is announced, a strike package can be constructed using only these predefined organizations; no new organizations need to be created. Conceptually, any combination of organizations may be temporary re-linked, although most are not tactically sensible. First, one of the element organizations of the squadron is selected to serve as the "Strike Package" root organization; in this case, it is Element B, and it is given the temporary alias "Package 53." Element B is chosen because one of its subordinate billets corresponds to the person selected to be the Strike Package Leader (i.e., the pilot with nickname/call-sign "Spam"). This command relationship is easily inferred by using two links. The first command link already exists because, this organization having single crewmember aircraft, every pilot billet automatically
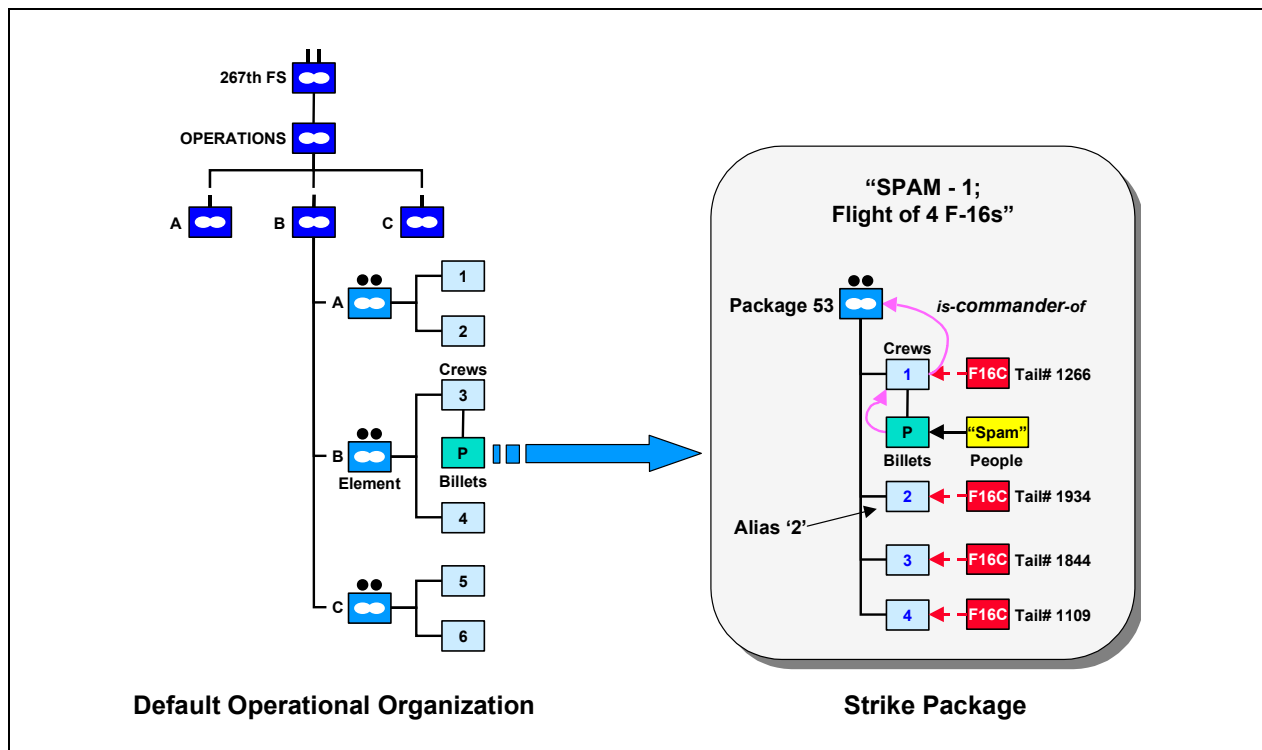

Figure 14: Building a Simple Strike Package

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"commands" the crew of which it is a part. However, a new OTOR that explicitly identifies Crew-3 as being the commander of the strike package must be temporarily added. Therefore,

IF P *is-commander-of* Crew-3 AND Spam *is-assigned-to* P AND
 Crew 3 *is-commander-of* Element B,
THEN Spam commands Element B, which has the temporarily alias of Package 53.

Second, one crew (from Flight B) per desired aircraft is attached to the strike package organization. Since crews 3 and 4 are already assigned to Element B, they are already included under the package. However, crews 5 and 6 from Element C are attached to the package via a separate OTOR. The crews can also be given aliases; in this case, they are "renumbered" 1 through 4—or realistically, "Spam-1" through "Spam-4."

Finally, aircraft are aligned to fill the package with the required assets. In this case, aircraft (materiel) with tail numbers are aligned with the crews of package 53. Previously in this paper, it has been stated that the concept of organization serves as the rallying point for which all other battlefield entities relate. This means that the location of the crew, which corresponds to the location of the aircraft, is maintained and exchanged as organizational information. If the aircraft has an onboard guidance system, then the location data are maintained as organizational attributes in the tables (or objects) of the database. The average location of all four aircraft (i.e., crews) can be maintained under the Element B (currently named Package 53) entry in the organization table. Should package 53 need to split into two groups, as illustrated in Figure 15, this is a simple task. First, another (unused) element of the flight is selected and given an alias. Then, two of the four crews are attached to the new element, and a commander is identified and
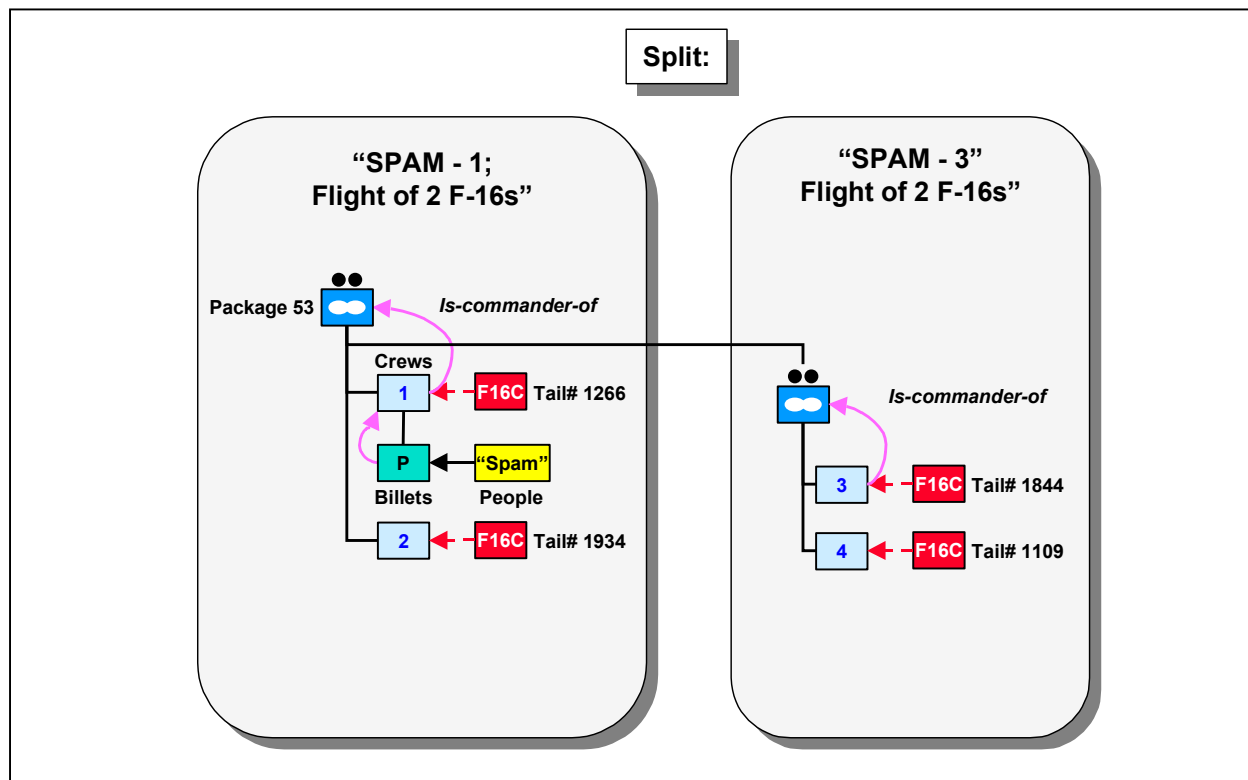

Figure 15: Strike Package Split During Operations

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explicitly annotated as per the previous example. Merging the strike package back together is accomplished by reversing this process.

It should be clear that this task organization process is equally applicable to large organizations, such as a Carrier Battle Group or a Marine Expeditionary Unit, as it is to small unit operations. The goal is to design a set of data abstractions and processing that are completely general in nature and homogeneous so that they can be applied seamlessly to any task organization problem. Flexibility is another feature of a general approach. For example, any organization that is routinely used may be added as a doctrinal organization. It doesn't matter if it is often "empty" (i.e., it doesn't have any permanently assigned subordinate organizations). Command Posts and watches are good examples of these cases.

It is also noted that these examples demonstrate details that would normally not be viewed by the operators of such a system. The user interface should be design to be familiar to the operator. The warrior should be able to be completely ignorant of the organizational semantics presented. Eventually, a common application could be developed for accomplishing task organization construction that is "standard issue" for any battle command system.

4. Summary

This paper introduces a technique for representing military organizational information called *Default Operational Organizations* (DOO). DOOs are graphical tree structures that provide enough detail to meet the requirements necessary to build arbitrary Orders of Battle across service and coalition boundaries. By closely studying how each Service organizes for combat, basic tenets were developed in an attempt to reduce many apparently (but not actually) disparate practices to a few fundamental concepts. The result is a set of guidelines based upon the "best practices" of all the services.

Three types of organizations were explicitly defined: (1) billets that correspond one-to-one with people, (2) crews that correspond one-to-one with major assets (i.e., materiel), and (3) doctrinal organizations that represent organizations that are routinely used in military operations but are rarely included in manning documents. Once the concept of organization is extended down to the billet level, crews are identified, and doctrinal organizations are added, the result is the default operational organization. Each organization (or node) of the DOO tree graph is assigned a worldwide unique organization identifier, or Org-ID. The DOO is a relatively stable structure that typically changes only over periods of months (i.e., when force structures are updated). Consequently, the data can be batch distributed ahead of time, as needed, to field commanders. From the default operational organization, a myriad of task organizations can be built, at any echelon, without creating any new organizations. Instead, existing organizations are temporarily re-linked (using their Org-Ids) and, often, are given a temporary alias. Examples are numerous: an Army Battalion Task Force, a Navy Carrier Battle Group, a Marine Expeditionary Unit, and a Joint Task Force or Joint Strike Package. All of these operational organizations can be created by re-linking existing organizations. The re-linking data are terse and can be disseminated via digital versions of the field order or plan (e.g., Operations Orders and Air Tasking Orders).

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The DOO also serves as the skeleton by which other entities can be related. Three type of relationships were introduced: OTORs, or Organization-to-Organization Relationships, to define associations between organizations (i.e., for task organizing); ETORs, or Equipment-to-Organization Relationships, to define associations between materiel and organizations (called alignments), and PTORs, or Personnel-to-Organization Relationships, to define associations between people and organizations—in particular, billets. Therefore, OTORs, ETORs, and PTORs can be used to pull together operational databases with those for personnel and logistics. This is because the concept of task organization serves as the foundation for these other battle command entities.

Task organization is at the heart of the Military Capability Package (MCP) process. The vision is that each Service will maintain an "org server" that contains its default operational organization in a common form that is readily accessible by the others services. The Army is currently pursuing this for Force XXI, and the DOO concept is fully extensible to coalition forces. Finally, a common application (e.g., a "Joint Task Organization Toolkit") could be developed to allow rapid "plug-and-play" of organizations across Service and coalition boundaries. This application would be a piece of "standard issue" software for battle command systems.

5. References

[Chamberlain, 1998] Sam Chamberlain. Technical Foundations for Emerging Battlefield Information Management. *Proceedings of the 1998 Command and Control Research and Technology Symposium.* Naval Postgraduate School, Monterey, CA, 29 Jun – 1 Jul 1998.

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[15] Postscript: CDR Patrick Dunn died in the September 11 terrorist attack at the Pentagon. He worked in the Navy Command Center.